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CORNSTALK DISEASE.

By R. A. CRAIG.

When cattle are first changed to the stalk fields and begin feeding on the stalks and the poor corn left in the fields, loss from disease occurs as a result of the change in the diet and from other causes. Such acute diseases as impaction, bloating, etc., are not uncommon, but in some years the greater part of the loss is not due to this class of disorders. In the fall and early winter of 1901-'02, cattle feeding in the stalk fields of Indiana died of a disease commonly called cornstalk disease, and a milder form of apparently the same disorder occurred in the seasons of 1905-'06. This disease was most prevalent in the central portion of the state.

The disease was first reported in November. An outbreak occurred in the neighborhood of Mulberry, and the general supposition was that it was caused by the cattle eating the moldy, spoiled corn, as a larger quantity than common had been left in the fields. Later, the Experiment Station received a few reports and inquiries from stockmen and veterinarians in other sections of the State. In order to get further information regarding the nature and prevalence of this disease, a letter of inquiry together with a list of questions was sent to the practicing veterinarians.

In answer to the question regarding the prevalence of cornstalk disease a number of veterinarians stated that it was prevalent in their locality, but reported very few cases as treated. Altogether about one thousand cases were reported and more than half of these were, without doubt, the disease in question. Most of the cases reported occurred during November and December. About one hundred of the affected

animals died. A large percentage of the deaths were in Allen and Clark counties. In the former county out of seventy cases there were twenty-three deaths, and in the latter, one hundred cases and forty deaths. In Clark county the disease began in August and continued until the latter part of March, and the symptoms and history given were not typical of cornstalk disease.

The following cases were reported by Dr. N. B. Combs, Mulberry, Indiana:

"During November, December and January, I treated sixty-five head of cattle, mostly cows, that were affected while pasturing in the stalk fields with a disease presenting a nervous train of symptoms. In most cases the disease responded readily to treatment and only a few of the affected animals died.

"One of the first cows treated had been pasturing on stalks for a week and a half, when the owner found her down in the field and unable to get up. I visited the farm an hour afterward and found the cow up and coming toward the barn. Her gait was uncertain and staggy. At times she appeared delirious. Spasms occurred and she would fall down and remain rigid for about half a minute. In one of these spasms she fell against the fence and remained in a half standing position until the muscles relaxed, when she dropped to the ground. She was given treatment but no noticeable improvement occurred until the third day. From this time on her condition gradually improved, and on the tenth day the recovery was complete.

"The day following my first visit three other cows in the herd (eight head) showed about the same train of symptoms as the first. One animal became paralyzed on one side of the body. All made a good recovery in about a week. These cattle were turned into the stalk field later and no further trouble occurred.

"In another herd that had been on stalk pasture for about two weeks a cow became paralyzed in her hind parts after showing an uncertain gait for three days. I was called and found her down, somewhat delirious and at times struggling violently, followed by spasms of the muscles. The cow did not improve and died six days after going down. Two other cases occurred in this herd. The symptoms shown were a staggering gait, partial loss of appetite and lessened milk secretion. All of the latter cases were mild and recovered in about four days.

"In a third outbreak the cattle had been pasturing on the stalks ten days before any of the animals were affected. One cow was found down and unable to get up. She remained quiet and in a natural

position unless disturbed. When slapped on her side or an attempt made to administer medicine, a severe spasm occurred, usually so violent as to make it impossible to administer treatment. On the following night the cow died and was cremated by the owner without reporting to me, hence an opportunity to make a postmortem examination was lost. This was the second death on this farm, a calf two months old having died a few days previous to my first visit. This animal had eaten shelled corn from the shredder that contained much mold. It also showed nervous symptoms. At the time of my visit I looked the herd over and found three cases of the disease besides the one that died, and three additional cases developed later. All recovered in from four to eight days. Two of the animals at times showed complete loss of control over the movement of their fore parts, causing them to fall and slide along on their briskets. Two weeks later the herd was turned into the same field and they were again affected. The symptoms this time were very mild.

"On an adjoining farm and at a time the above animals were affected, three cows showed symptoms of the same character. These cows were down when I first visited them. Two improved rapidly and in three days were on their feet. The third showed marked general improvement but could not support weight on her hind limbs. She continued in this condition for several weeks and was finally killed. Within a few days after the disease developed the herd was returned to the stalk field and no further trouble occurred. In about four weeks the cattle were turned into an adjoining field which had not been pastured, and on the fourth and fifth days, after changing fields three of animals were affected and showed the usual train of symptoms. The herd was returned to this field a little later and the disease did not recur. After pasturing here for a few weeks they were turned into a new field of stalks the last week in December, and the first week six new cases developed. All made a recovery. Weakness and knuckling over in the posterior fetlock joints were especially noticeable in the latter cases. However, these symptoms occurred in a number of the former cases.

"The body temperature of the diseased animals remained about normal throughout the attack. In several cases faeces were passed at frequent intervals, and were, perhaps, more soft than common. None of the cattle had a diarrhoea. A number of the animals that were affected did not thrive well for several months, and late in the spring (May) did not appear as thrifty as the cattle that had not been affected. Knuckling over in the fetlock joints was still shown by a few animals."

The following cases were reported by Dr. A. R. Thompson, Attica, Indiana:

"During the months of December and January I treated a number of cattle that were affected with what appeared to be a new type of cornstalk disease. In most cases the animal had a good appetite, the body temperature remained normal or sub-normal, and no symptoms of a digestive disease were manifested. The symptoms were of nervous character, such as a staggering gait, falling down and getting up again, eyes staring, pupils dilated and finally paralysis. All of the cattle were pasturing on stalks.

"The following is a brief summary of the symptoms shown by a few of the cattle that I was called to treat.

"A bunch of twenty-five yearling steers had been running in a stalk field about two weeks when I was called to treat two of them. One showed the usual staggering gait, the other was down and unable to get onto its feet. Both of the yearlings made a good recovery and the herd was returned to the stalk field without further appearance of the disease.

"On another farm where I was called two cows that had been pasturing on cornstalks were affected. At the time of my visit they were both down and unable to rise. They made a good recovery. About ten days later another cow was affected in the same way as the former. Just previous to my first visit a cow 'went down' in the field and the owner, thinking that she would not recover, killed her.

"In a large herd of steers seven were affected in the same afternoon. Five of these animals were able to get up the following morning and to all appearances had recovered. The other two steers made good recoveries later.

"Only two deaths occurred among the cattle treated. These, I believe, were largely due to exhaustion and exposure, as they had been lying in the wet and mud for about twenty-four hours before discovered."

Drs. Erdel and Smith, Frankfort, Indiana, stated in answer to the letter of inquiry that they first attributed this disease among the cattle in their locality to eating dry, mouldy corn. In one instance two cows that had not pastured on the cornstalks, but were pasturing on a blue grass timber pasture, had the same disease as the cattle that were feeding in the stalk fields. The grass in the pasture was long and had fallen down.

In Bulletin No. 58 of the Kansas Experiment Station, Dr. Mayo reports an outbreak of cornstalk disease of a more fatal form, but similar in many ways to the form of the disease that occurred in this state the past year.

The outbreak occurred in a herd of seventy-five three-year-old steers that were running in an eighty acre stalk field. On the fifth day some of the cattle began showing symptoms of disease. Dr. Mayo's report of this outbreak is as follows:

"The stalk field was a mile or more from the ranch and feed lots, where all the cattle were, except six that had been left in the stalk field. Of these brought to feed lot three were down and five or six were noticeably affected, as shown by uncertain gait, lack of co-ordination and knuckling of hind legs. The steers that were down had been hauled to sheltered places and were nibbling at millet hay and eating a little corn that was given them. Their temperatures were 102 1-5 degrees F., 102 1-2, 102 1-5 degrees. The respiration and pulse were faster than normal but this was probably caused by the excitement of drawing them upon a sled. There was paralysis of the hind quarters.

"Of the steers that were necessarily left in the stalk field one was dead and six had been hauled out of the stalk field and placed on the south side of a haystack in an adjoining meadow. Two of the six had been able to regain their feet during the night and had wandered away. Of the remaining four, three presented the same appearance and condition as those at the feed lot, except their temperatures were slightly lower, 101 3-5, 102, 102 1-5. Their bodies had been covered by hay, of which they ate a little, and also a little corn that was given them. If approached they would shake their heads and make efforts to rise, but were unable to do so on account of paralysis of the hind parts. All of these steers were lying in normal position upon the sternum or 'brisket.' Another steer more seriously affected was lying upon the right side, and was quite badly bloated. This bloating was probably caused from indigestion induced by lying in one position on the side. Tapping the rumen gave temporary relief. This steer appeared to be in no pain. The eyes were congested and were discharging some muco-purulent matter. His temperature was 101 3-5. The dung of all the sick steers was very dark colored and foetid, yet containing quite a little undigested corn. The remaining (seventh) steer was dead. Had been dead two days, but as the weather had been cold decomposition was not marked. The steer was lying in a depression or 'draw' that contained some standing water and was quite mirey. An autopsy revealed congestion of the brain and lungs,

the latter severe. Rumen was partially filled with well masticated corn stalks. There was no impaction of the omasum (manifolds) the abomasum, or true stomach was empty of food but congested and contained a quantity of mucus. Small intestines were congested. Large intestines congested and filled with dark, foetid manure, mixed with considerable mucus. The heart was congested. The liver, spleen and kidneys appeared normal. After this steer was taken ill he was exposed to a cold sleet and snow storm and his death probably resulted from a combination of disease and exposure.

"A hasty examination of the stalks in one corner of the field failed to find any noticeable abnormal conditions, although Mr. Gregory mentioned that there had been considerable rotten corn in the field.

"Out of the seventy-five head of steers twenty were "visibly" affected, sixteen were "absolutely helpless," and ten died.

"The history and symptoms as exhibited by these cattle would indicate that they were affected by some poisonous substance which had a paralyzing action upon the nervous system, as shown by loss of control of hind parts and congestion of lungs, which indicates a weak action of the heart.

"The source of this poisonous substance, if such it be, may be in the rotten corn; something of the nature of a ptomaine or nitrogenous base formed in the decomposing corn.

EXPERIMENTS MADE IN THE FEEDING OF SPOILED, MOLDY CORN TO HORSES AND CATTLE.

In January, 1906, four sacks of spoiled, moldy corn were gathered from a stalk field adjoining a field in which cattle had developed corn-stalk disease. A healthy heifer weighing three hundred and fifty pounds was fed from four to five pounds (twelve to seventeen ears) of this corn twice a day. In addition stover was fed. On the afternoon of the sixth day of the test the heifer appeared weak, went down in the stall and was helped up twice during the afternoon. When down she struggled some, and when helped up "shivered" as though cold. In the evening she was still trembling and appeared weak. The weakness disappeared the following day. A few days later a slight twitching of the body muscles was noticed. The feeding test extended over a period of sixteen days. Her appetite remained good throughout the test.

During the fall and early winter of 1898-'99, Bitting¹ reported losses in horses and cattle, supposed to have been due to feeding on spoiled corn. By feeding corn meal that was inoculated with a pure culture of a mold (*fusarium* sp.) made from the spoiled corn, he produced salivation and redness of the gums of the two horses used in the experiment. Later, spoiled corn was fed. On the fifth day one horse showed a slight salivation, colic pains and diarrhoea. On the seventh day a noticeable incoordination in moving about and stupor. For two days the animal stood with the head pressed against the wall. A quick recovery followed and the nervous disease from which horses were reported as dying did not develop. The second horse showed nothing more than a slight irritation to the mouth.

Bodin and Gautier² from the study of the fungus *Aspergillus fumigatus* in culture and inoculation of animals have shown that it produces a toxin which may be compared with the toxins of bacteria. For the formation of this toxin in culture they found it necessary to have a mixture of protein and some carbohydrate. The symptoms of poisoning produced by the toxin were muscular convulsions followed by death within a few hours, if the animal did not recover. Among the experimental animals used, the rabbit and dog were found most susceptible to this poison.

CAUSES OF CORNSTALK DISEASE.

Many theories as to the cause of this disease have been advanced, but none of them has proven satisfactory. In its early history stockmen were of the opinion that eating the corn smut caused sickness and death among animals pasturing in stalk fields. The popular opinion regarding the disease producing properties of smut led to a large number of feeding tests. These tests and the observations of stockmen as well have proven beyond a doubt that corn smut in itself is not poisonous to animals pasturing on stalks.

Billings³ attributed cornstalk disease to germ infection. The infectious germ he believed identical with a bacillus which produced a disease of corn known as "corn blight" or Burrill disease. Cultures of this bacillus from the tissues of cattle that had died in the fields, when fed to rabbits or injected into the tissues caused death within a few days. A pure culture injected into the jugular vein of a calf

1. Twelfth Annual Report Indiana Agricultural Experiment Station.

2. *Ann. Inst. Pasteur*, 20, (1906), No. 3, pp. 209-224, abstract from *Experiment Station Record*, Vol. XVIII, No. 1, p. 88.

3. *Nebraska Agricultural Experiment Station, Bulletin* Nos. 7, 8, 9 and 10, pp. 165-211.

caused death in two days. Later investigators⁴ demonstrated the non-infectious character of the Burrill bacillus by feeding cornstalks affected with this disease. Furthermore, a bacterial examination of the organs of cattle that died in the stalk fields showed no single species of bacteria constantly present.

Brimhall⁵ found that all outbreaks of so-called cornstalk disease occurring in Minnesota were not this disease but a specific affection caused by a cocco-bacillus, and known as haemorrhagic septicaemia. The clinical symptoms occurring in the latter disease differ in many respects from the former, in that they do not so closely resemble a toxic poisoning and are not as uniformly nervous in character. At the outset of haemorrhagic septicaemia there is usually a high fever, diarrhoeal discharges may occur, blood stained urine is sometimes passed, and symptoms of a severe congestion and inflammation of the lungs may be manifested. The postmortum lesions are often marked, as would be expected in a disease of this character.

Mayo⁶ describes two outbreaks of poisoning in cattle resulting from feeding on corn fodder containing a large quantity of nitrate of potassium. Beneath the leaf sheaf which surrounded the stalk the nitrate had crystalized in fine white crystals that resembled a white mold. A chemical analysis of samples of stalks from the fields where the poisoning occurred showed 18.8 per cent of potassium nitrate. The occurrence of nitrate in perceptible quantities in cornstalks is, without doubt, very rare, as none of the later investigators have reported crystals in any form as present beneath the leaf sheath or in the stalk.

After a careful study of cornstalk disease, Moore⁷ stated that the accumulated data indicated a disease of a toxic nature. The character of the poison was not determined but it appeared to be restricted to the corn plant. He considered the observations made by Mayo of much importance, as the finding of poison in cornstalks grown under certain conditions might afford a key to the cause of the disease.

During the summer of 1901 Peters⁸ investigated a number of deaths among cattle that resulted from feeding on growing sorghum. In most fields where loss was reported the sorghum appeared stunted. Samples of leaves and stalks were collected and in a watery extract

4. Kansas Agricultural Experiment Station, Bulletin No. 53, Bulletin No. 16, Bureau of Animal Industry.

5. Report of Minnesota State Board of Health, 1900-1903.

6. Kansas Agricultural Experiment Station, Bulletin No. 49.

7. Bulletin No. 10, Bureau of Animal Industry.

8. Nebraska Agricultural Experiment Station, Bulletin No. 52.

from these samples prussic acid was found. Slade estimated that seven or eight pounds of the fodder contained sufficient poison to kill one animal.

Because of the close resemblance between toxic poisoning from sorghum and the symptoms of cornstalk disease, Price⁹ deemed it advisable to examine cornstalks for the substances which produce prussic acid in plants. Samples of stalks from fields in which cattle had died were obtained. In these samples he discovered an enzyme which had the property of decomposing a glucoside (amygdalin) and thereby producing prussic acid. However, no glucoside capable of forming this poison as a result of enzyme action was found. The results were not regarded as conclusive, as only a few samples were examined, and the failure to discover a suitable glucoside did not prove its absence in the corn plant, or in other plants in the field.

In an outbreak that occurred a few years ago the possible influence of certain conditions of growth and development of corn in causing the disease was noted. In a neighborhood where the disease was prevalent in its most fatal form twenty-two head of cattle were pastured in a fifteen-acre stalk field for three weeks. They were then turned into an adjoining forty-acre field. Toward the end of the first week three head of stock cattle died. The herd was then taken out of the stalk field and no further loss occurred. The only apparent difference in the two fields was that the forty acres of corn were badly injured by drought during the growing season, and the fifteen acres, which were planted late, yielded a full crop.

CONCLUSION.

The name cornstalk disease is meaningless, so far as the specific cause of the disease is concerned. In the use of this term we designate the condition under which the sickness and deaths occur. There are, apparently, grouped under this one head several diseases which occur under definite conditions and present a rather uniform line of symptoms. The symptoms closely resemble certain forms of toxic poisoning, but only one investigator reports the finding of a poisonous substance (potassium nitrate). Hence, it is very doubtful if this nitrate is a frequent cause of loss among animals pasturing on cornstalks.

The possibility of the presence in cornstalks of such substances as produce prussic acid is suggested because of the resemblance that the

9. Twenty-First Annual Report. Bureau of Animal Industry. Enzymes in Corn Stalks.

symptoms, and sometimes the conditions under which the disease occurs, has to sorghum poisoning. A reasonable explanation for the failure of investigators to find a toxic substance is that all cornstalks, or portions of the corn plant, do not contain the poison. In a feeding test with spoiled ear corn the failure to produce the same disease as occurs in the field may be due to the different conditions. Animals in the field are able to select their feed. Judging from the small percentage of the herd that is usually affected at any one time, all of the stalks, leaves, and undeveloped and spoiled corn are not injurious, for if the injurious substance was present in all of the food a larger number of the animals in the herd would suffer and the cases would not be distributed over a period of several days, or several weeks.



